80/227/CDV

COMMITTEE DRAFT FOR VOTE (CDV)
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Titre :

(This CDV is circulated in English only)

Title :

Draft IEC 60872-3 – Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 3: Electronic plotting aid (EPA) – Performance requirements – Methods of testing and required test results

Introductory note

IEC 60872 was published in 1987 and amended in 1991. The revision of IEC 60872 was initiated in 1993 (see documents 80(Sec.)82 and 80(Sec.)88). This is part 3 of the revision work.

Part 3 of IEC 60872 for Electronic plotting aids (EPA) completes the IEC TC 80 series for radar plotting aids. It incorporates the IMO performance requirements contained in IMO Resolution MSC.64 (67) Annex 4 – Appendix 2 for such electronic plotting aids. The EPA provides manual direct plotting and is intended for small ships fitted with a gyrocompass or a transmitting electromagnetic compass and a speed and distance measuring equipment (SDME).

Part 1 of the series for Automatic radar plotting aids (ARPA) has been published in 1998 and Part 2 of the series for Automatic tracking aids (ATA) has been published in 1999-01.

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	**Parallel IEC CDV/CENELEC Enquiry**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS - Radar plotting aids – Part 3: Electronic plotting aid (EPA) - Performance requirements - Methods of testing and required test results

FOREWORD

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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60872-3: Radar plotting aids - Part 3: Electronic plotting aid (EPA) has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of this standard is based on the following documents:

FDIS	Report on Voting

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annexes A, B, C and D form an integral part of this standard.

A bilingual version of this standard may be issued at a later date.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS - Radar plotting aids - Part 3: Electronic plotting aid (EPA) - Performance requirements - methods of testing and required test results

1 Scope

This International Standard specifies the minimum operational and performance requirements, methods of testing and test results for equipment that complies with performance standards not inferior to those adopted by the International Maritime Organisation (IMO) in Resolution MSC.64 (67) Annex 4 – Appendix 2. In addition, this standard takes account of IMO resolution A.694 and is associated with IEC 60945.

When a requirement in this standard is different from IEC 60945, the requirement in this standard shall take precedence.

The electronic plotting aid for manual direct plotting is intended for small ships fitted with either a gyrocompass or transmitting marine electromagnetic compass conforming to ISO 11606, and a speed and distance measuring equipment (SDME) conforming to IMO Resolution A.824 and IEC 61023. This plotting aid is not suitable for ships classed as high-speed craft.

All text of this standard, in which the wording is identical to that in IMO Resolution MSC.64 (67) Annex 4 – Appendix 2 are printed in *italics* and the resolution and paragraph numbers are indicated in brackets.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this part of IEC 60872. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60872 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid international standards.

IEC 60872-1:1998, Maritime navigation and radiocommunication equipment and systems - Radar plotting aids – Part 1: Automatic radar plotting aid (ARPA) - Operational and performance requirements, methods of testing and required test results

IEC 60872-2:1998, Maritime navigation and radiocommunication equipment and systems - Radar plotting aids- Part 2: Automatic tracking aid (ATA) - Operational and performance requirements, methods of testing and required test results

IEC 60936-1:1999, Maritime navigation and radiocommunication equipment and systems - Radar – Part 1: Shipborne radar - Operational and performance requirements, methods of testing and required test results

IEC 60945:1997, Maritime navigation and radiocommunication equipment and systems - General requirements, methods of testing and required test results

IEC 61023:1999, Maritime navigation and radiocommunication equipment and systems - Speed and distance measuring equipment (SDME) – Operational and performance requirements – methods of testing and required test results

IEC 61162-1:1996, Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners

IEC 61162-2:1997, Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 2: Single talker and multiple listeners, high speed transmission

ISO 11606: 1999, Ships and marine technology – marine electromagnetic compasses

ISO 9000 Series: 1987, Quality management and quality assurance standards

IMO Resolution A.694: 1991, General requirements for shipborne radio equipment forming part of the global maritime distress and safety system and for electronic navigational aids

IMO Resolution A.823: 1995, Performance standards for automatic radar plotting aids (ARPAs)

IMO Resolution A.824: 1995, Performance standards for devices to indicate speed and distance

IMO MSC/Circular 603: 1993, Guidelines on display sizes and techniques for navigational purposes

IMO MSC.64 (67): 1996, Annex 4 - Performance standards for radar equipment - and – Appendix 2 – Electronic plotting aids

IHO S-52: 1994, Specifications for chart content and display aspects of ECDIS

3 Performance requirements

3.1 Introduction

3.1.1 ”Electronic plotting aid” (EPA) shall, in order to improve the standard of collision avoidance at sea:

1 reduce the workload of observers by enabling them to obtain information about plotted targets so that they can perform as well with several separate targets as they can by manually plotting a single target;

2 provide continuous, accurate and rapid situation evaluation.

3.1.2 The radar facilities provided by an EPA display shall comply with those clauses of IEC 60936-1 appropriate to its mode of use.

3.1.3 In addition to the general requirements contained in IEC 60945, the EPA shall comply with the following minimum requirements.

3.1.4 Additional ARPA or ATA facilities, not mandated in this EPA standard, may be provided. Such facilities shall comply with IEC 60872-1 and IEC 60872-2 as applicable.

3.1.5 Quality assurance

The EPA shall be designed, produced and documented by companies complying with ISO 9000, as applicable.

3.2 Definitions

Definitions of terms used in these performance standards are given in annex A.

3.3 (MSC.64 (67)/Annex 4/Appendix2/2) Performance standards

3.3.1(*App2/2.1*) *The electronic plotting aid* shall *provide a means to plot a minimum of 10 targets on a radar display.*

See annex D for a description of how manual plotting shall be implemented.

3.3.2 (*App2/2.2)* Range scales

3.3.2.1 *It* shall *be possible to plot targets on the 3, 6 and 12 nautical mile range scales. The facility may be provided on additional range scales.* There shall be a positive indication of the range scale in use. *Plots* shall *be maintained when switching between range scales.* The methods of operation that are provided shall be clearly described in the manufacturer's manual.

3.3.2.2 After changing range scales on which the "electronic plotting aid" facilities are available or on resetting the display, full plotting information shall be displayed within a period of time not exceeding one scan of 360^{0}.

3.3.3 *(App2/2.3) It* shall *be possible to plot targets with a relative speed up to 75 knots.*

3.3.4 *(App2/2.4) It* shall *be possible for the operator to adjust the CPA/TCPA limits and the vector time.*

3.3.5 Plot positions and identification

3.3.5.1 *(App2/2.5) Plot positions* shall *be identified by an approved symbol* (see annex C symbols 1, 4 or 6) *and an associated plot number. It* shall *be possible to switch off the plot number.*

3.3.5.2 Automatically applied 'target identities' shall not be re-used until, as a minimum, the number assigned equals the maximum number of plotted targets.

3.3.6 *(App2/2.6) The minimum lapsed time between any two plots* shall *be greater than 30 s.*

3.3.7 *(App2/2.7) After the second plot, a vector* shall *be displayed on the target. It* shall *be possible to select a true or relative vector. There* shall *be a positive indication of vector mode,* including an indication of sea or ground stabilisation.

.1 vectors displayed shall be time-adjustable;

.2 a positive indication of the time-scale of the vector in use shall be given.

3.3.8 *(App2/2.8) The vector origin* shall *move across the screen at a rate and direction defined by the calculated true course and speed.*

3.3.9 *(App2/2.9) It* shall *be possible to correct the position of a plot.*

3.3.10 *(App2/2.10) It* shall *be possible, on demand, to display the following data on a selected target:*

.1 plot number: time since last plot (min);
.2 present range of the target;
.3 present true *bearing of the target;*
.4 predicted target range at the closest point of approach (CPA);
.5 predicted time to CPA (TCPA);
NOTE - If the CPA has passed, it shall be indicated by a TCPA with a negative (-) sign.
.6 calculated true course of target;
.7 calculated true speed of target.

The selected plot shall *be clearly identified with an approved symbol* (see annex C symbol 12) *and the plot data* shall *be displayed outside of the screen radar area.* If data is required for more than one target at the same time each symbol shall be separately identified, for example with a number adjacent to the symbol.

3.3.11 *(App2/2.11) There* shall *be an indication* by a text message including the plot number *of any plot that is not updated for 10 min. The plot* shall *be dropped if the time between consecutive plots exceeds 15 min.*

3.3.12 Display

3.3.12.1 The display may be a separate or integral part of the ship's radar. However the "electronic plotting aid" display shall include all the data required to be provided by a radar display in accordance with the performance standards for navigational radar equipment.

3.3.12.2 The design shall be such that any malfunction of "electronic plotting aid" parts producing data additional to information to be produced by the radar as required by the performance standards for navigational equipment shall not affect the integrity of the basic radar presentation.

The equipment shall be regarded as complying with 3.3.4.2 if the design is such that, where practicable, correct operation of the radar system in accordance with IEC 60936-1 will not be affected by malfunction of any EPA sub-system that is not an essential part of the radar.

3.3.12.3 The "electronic plotting aid" shall be capable of operating with a relative or true motion display with "north-up" azimuth stabilisation. There shall be a positive indication of the display mode and orientation in use.

3.3.12.4 The "electronic plotting aid" information shall not obscure the visibility of radar targets. The display of "electronic plotting aid" data (vector and associated symbol) shall be under the control of the radar observer. It shall be possible to cancel the display of unwanted "electronic plotting aid" data within 3 s of command.

3.3.12.5 Means shall be provided to adjust independently the brilliance of the "electronic plotting aid" data and radar data, including complete extinction of the "electronic plotting aid" data.

3.3.12.6 The method of presentation shall ensure that the "electronic plotting aid" data is clearly visible in general to more than one observer in the conditions of light normally experienced on the bridge of a ship by day and by night. Screening may be provided to shade the display from sunlight but not to the extent that it will impair the observer's ability to maintain a proper lookout. Facilities to adjust the brightness shall be provided.

3.3.13 Operational alarms and indications

3.3.13.1 The "electronic plotting aid" shall have the capability to alarm the observer with a visual and audible signal of any tracked target that is predicted to close within a minimum, range and time,

chosen by the observer. The target causing the alarm shall be clearly indicated with the relevant symbols (see annex C symbol 8) on the display.

3.3.13.2 It shall be possible for the observer to activate or de-activate the audible alarm capability.

3.3.14 Connections with other equipment

3.3.14.1 The connection of the "electronic plotting aid" to any other equipment shall not degrade the performance of that equipment. This requirement shall be met whether the "electronic plotting aid" is operating or not. Additionally the "electronic plotting aid" shall be designed to comply with this requirement under fault conditions as far as is practicable.

3.3.14.2 Serial interfaces provided, shall comply with the IEC 61162 series, as applicable.

4 Methods of testing and required test results

4.1 General

Before these tests, the equipment under test (EUT) shall be subjected to and satisfy the relevant parts of IEC 60945.

4.2 (3.3.1 to 3.3.11) Description of manual plotting tests

4.2.1 General principle

Comparing target data (CPA, TCPA, speed and course) gained simultaneously from the EUT of the EPA device and from evaluation of plot-positions (range and bearing) while plotting a cursor position simulating a target position.

4.2.2 Operational conditions

The tests shall be carried out by entering plots to pre-defined positions (range and bearing) and own ship data according to 'test scenarios' covering the most relevant sources of potential error. The 'test scenarios' to be used are given in table 1 and are detailed in annex B. Faults of sensors and precision of positioning the cursor over a real radar target have no effects on these tests - only the accuracy of the EPA calculations are tested.

Scenario 1	Target with nearly the same course and a risk of collision (CPA = 0); after 10 min change of own course 45 ^{0} starboard (CPA > 0).
Scenario 2	Own ship at anchor (SPD = 0) at time = t_0; target approaches from 135 ^{0} exactly towards own position (CPA = 0) ; own ship gets underway at t_0 + 10 min, and speed increases to 5 knots.
Scenario 3	Target with exactly the same course and speed; after 7 min reduction of own speed to 5 knots; after 12 min change of target course so that CPA= 0.
Scenario 4	Target with exactly opposite course; after 10 min change of own course 10 ^{0} starboard to CPA > 0.
Scenario 5	Target with crossing course and a risk of collision (CPA= 0); after 7 min a reduction of own speed, target reduces accordingly (CPA = 0); after 13 min own course is changed 90 ^{0} to port so that CPA > 0.
Scenario 6	Target with opposite course manoeuvres to a collision course (CPA = 0); after 13 min, own speed and course are changed; target changes its course accordingly (CPA = 0).

Table 1 - Test scenarios

4.2.3 Method of measurement

With the gain reduced to a minimum or off. Own ship data course and speed shall be set to the required values by using “manual settings” in steps.

Placing the cursor to the range and bearing values given by the scenario shall set plot marks.

The test scenarios shall be performed in plot intervals of 3 min. Target data CPA, TCPA, course and speed obtained by the EUT and the range and bearing values used by the EUT are read out and recorded.

4.2.4 Results required

All data sets shall be evaluated by using these valid values for range and bearing, compared with the target data obtained by the EUT (thus target data are not compared with the original scenario data; the scenario is only a means of making the tests comparable). Acceptable tolerances for evaluation of scenarios shall be:

1 CPA ± 0,1 nautical miles (nm) for CPA < 1 nm and range < 6 nm. In other cases, ± 5% of the range scale in use.
2 TCPA ± 2 min for TCPA < 10 min and range < 6 nm. In other cases, ± 20 % of the calculated TCPA.
3 Course ± 5 ^{0}.
4 Speed ± 1 knot.

4.3 (3.1.5) Quality assurance

Check by practical demonstration and inspection of the relevant documentation.

4.4 (3.3.12) Display

Check by inspection of the equipment, for compliance with the requirements of 3.3.4.

4.5 (3.3.13) Audible alarms

Check by inspection of the EUT.

4.6 (3.3.14) Connections with other equipment

Check by practical demonstration and inspection of the documentation.

Annex A
(normative)

Definitions of terms to be used in connection with "electronic plotting aids" and radar performance standards
(Annex 1 to appendix 1 of IMO Resolution MSC.64(67) Annex 4)

Azimuth stabilised display:	*A display in which the azimuth orientation relative to a nominated true bearing is fixed*
CPA/TCPA:	*Closest point of approach and time to closest point of approach limit as defined by the observer to give warning when a tracked target or targets will close to within these limits from own ship*
Ground stabilisation:	*A mode of display whereby own ship and all targets are referenced to the ground using ground track or set and drift inputs*
Heading:	*The direction in which the bows of a ship are pointing expressed as an angular displacement from north*
North-up display:	*An azimuth stabilised display in which a line connecting the centre of own ship with the top of the display is north true bearing*
Relative bearing:	*The direction of a target from own ship expressed as an angular displacement from own ship's heading*
Relative course:	*The direction of motion of a target relative to own ship's position expressed as an angular displacement from north. It is deduced from a number of measurements of target range and bearing on own ship's radar*
Relative motion:	*The combination of relative course and relative speed*
Relative motion display:	*A display on which the position of own ship remains fixed and all targets move relative to own ship*
Relative speed:	*The speed of a target relative to own ship's position. It is deduced from a number of measurements of target range and bearing on own ship's radar*
Relative vector:	*The predicted movement of a target relative to own ship*
Sea stabilisation:	*A mode of display whereby own ship and all targets are referenced to the sea, using gyro heading and single axis log water speed inputs*
Target:	*Any object fixed or moving whose position and motion is determined by measurements of range and bearing on radar*
Target's predicted motion:	*A prediction of future target motion based on linear extrapolation from its present motion as determined by past measurements of its range and bearing on the radar*

Trails:	*Tracks displayed by the radar echoes of targets in the form of a synthetic afterglow. The trails may be either relative or true. The true trails may be sea or ground stabilised*
True bearing:	*The direction of a target from own ship or from another target expressed as an angular displacement from north*
True course:	*The true direction of motion of a target expressed as an angular displacement from north. It is obtained by a vector combination of target relative motion and own ship's true motion*
True motion:	*The combination of true course and true speed*
True motion display:	*A display across which own ship and each target moves with its own true motion*
True speed:	*The speed of a target obtained by a vector combination of target relative motion and own ship's true motion **
True vector:	*The predicted true motion of a target as a result of own ship's direction and speed input. The true vector may be either displayed with reference to the water or to the ground*

* *For the purposes of these definitions there is no need to distinguish between sea and ground stabilisation.*

NOTE - Where reference is made to target range, bearing, relative course or relative speed, closest point of approach (CPA) or time to closest point of approach (TCPA), these measurements are made with respect to the radar antenna.

Annex B
(normative)

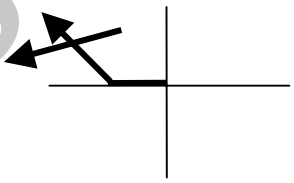
Operational scenarios

NOTE - In all scenarios the following abbreviations are used:

True bearing – t: Relative bearing – r: Nautical miles – nm: Knots - kt
SPD – speed: CPA – closest point of approach: TCPA – time to closest point of approach
CSE – course: RNG – range: BRG - bearing

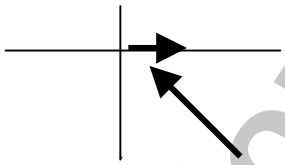
Scenario 1:

Target with nearly same course and risk of collision (CPA = 0);
after 10 min change of own course 45 ^{0} starboard (CPA > 0).



Plot Nº	Time (s)	Own Ship		Marker		Target Data					
		SPD (kt)	CSE (^{0})	RNG (nm)	BRG (^{0}) t	SPD (kt) r	CSE (^{0}) r	SPD (kt) t	CSE (^{0}) t	CPA (nm)	TCPA (min)
1	0,00	25	270	5,00	315,00						
2	3,00	25	270	4,85	315,00	3,0	135,0	23,0	264.7	0,0	97,0
3	6,00	25	270	4,70	315,00	3,0	135,0	23,0	264,7	0,0	94,0
4	9,00	25	270	4,55	315,00	3.0	135,0	23,0	264,7	0,0	91,0
	10,00	**25**	**315**	**4,50**	**315,00**	**3,0**	**135,1**	**23,0**	**264,7**	**0,0**	**90,0**
5	12,00	25	315	4,20	306,93	20,5	194,7	23,0	264,7	3,9	4,6
6	15,00	25	315	3,93	292,96	20,5	194,7	23,0	264,7	3,9	1,6
7	18,00	25	315	3,91	277,96	20,5	194,7	23,0	264,7	3,9	-1,4
8	21,00	25	315	4,16	263,82	20,5	194,7	23,0	264,7	3,9	-4.4

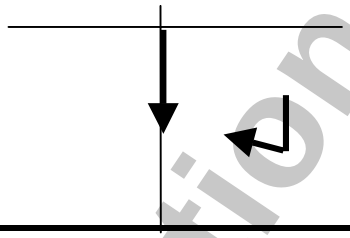
Scenario 2:



Own ship at anchor (SPD = 0) at time t_0; target approaches from 135 ^{0} exactly towards own position (CPA = 0); after 10 min own ship gets underway at t_0 + 10 min and speed increases to 5 knots.

Plot Nº	Time (s)	Own Ship		Marker		Target Data					
		SPD (kt)	CSE (^{0})	RNG (nm)	BRG (^{0}) t	SPD (kt) r	CSE (^{0}) r	SPD (kt) t	CSE (^{0}) t	CPA (nm)	TCPA (min)
1	0,00	0	0	5,00	135,00						
2	3,00	0	0	4,50	135,00	10,0	315,0	10,0	315,0	0,0	27,0
3	6,00	0	0	4,00	135,00	10,0	315,0	10,0	315,0	0,0	24,0
4	9,00	0	0	3,50	135,00	10,0	315,0	10,0	315,0	0,0	21,0
	10,00	**5**	**90**	**3,33**	**135,00**	**10,0**	**315,0**	**10,0**	**315,0**	**0,0**	**20,0**
5	12,00	5	90	2,88	137,34	14,0	300,4	10,0	315,0	0,8	11,8
6	15,00	5	90	2,22	142,61	14,0	300,4	10,0	315,0	0,8	8,8
7	18,00	5	90	1,60	152,14	14,0	300,4	10,0	315,0	0,8	5,8
8	21,00	5	90	1.07	172,27	14,0	300,4	10,0	315,0	0,8	2,8

Scenario 3:

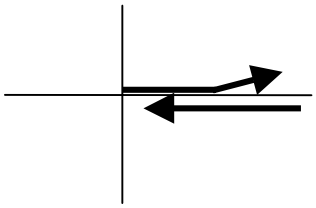


Target with exactly the same course and speed; after 7 min reduction of own speed to 5 knots; after 12 min change of target course so that CPA = 0.

Plot Nº	Time (s)	Own Ship		Marker		Target Data					
		SPD (kt)	CSE (^{0})	RNG (nm)	BRG (^{0}) t	SPD (kt) r	CSE (^{0}) r	SPD (kt) t	CSE (^{0}) t	CPA (nm)	TCPA (min)
1	0,00	10	180	3,00	135,00						
2	3,00	10	180	3,00	135,00	0,0	0,0	10,0	180,0	2,1	**
3	6,00	10	180	3,00	135,00	0,0	0,0	10,0	180,0	2,1	**
	7,00	**5**	**180**	**3,00**	**135,00**	**0,0**	**0,0**	**10,0**	**180,0**	**2,1**	**
4	9,00	5	180	3,12	137,16	5,0	180,0	10,0	180,0	2,1	- 27,5
5	12,00	5	180	3,31	140,11	5,0	180,0	10,0	180,0	2,1	- 30,5
6	15,00	5	180	2,64	140,11	13,3	320,1	10,0	301,4	0,0	11,9
7	18,00	5	180	1,98	140,11	13,3	320,1	10,0	301,4	0,0	8,9
8	21,00	5	180	1,31	140,11	13,3	320,1	10,0	301,4	0,0	5,9

** TCPA > 99 or undefined

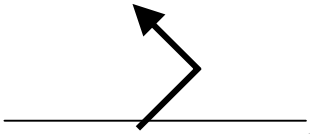
Scenario 4:



Target with exactly opposite course; after 10 min change of own course 10 ^{0} starboard to CPA > 0.

Plot Nº	Time (s)	Own Ship		Marker		Target Data					
		SPD (kt)	CSE (^{0})	RNG (nm)	BRG (^{0}) t	SPD (kt) r	CSE (^{0}) r	SPD (kt) t	CSE (^{0}) t	CPA (nm)	TCPA (min)
1	0,00	10	90	5,00	90,00						
2	3,00	10	90	4,00	90,00	20,0	270,0	10,0	270,0	0,0	12,0
3	6,00	10	90	3,00	90,00	20,0	270,0	10,0	270,0	0,0	9,0
4	9,00	10	90	2,00	90,00	20,0	270,0	10,0	270,0	0,0	6,0
	10,00	**10**	**80**	**1,67**	**90,00**	**20,0**	**270,0**	**10,0**	**270,0**	**0,0**	**5,0**
5	12,00	10	80	1,01	93,30	19,9	265,0	10,0	270,0	0,1	3,0
6	15,00	10	80	0,15	175,00	19,9	265,0	10,0	270,0	0,1	0,0
7	18,00	10	80	1,10	256,70	19,9	265,0	10,0	270,0	0,1	- 3,0
8	21,00	10	80	2,00	260,83	19,9	265,0	10,0	270,0	0,1	- 6,0

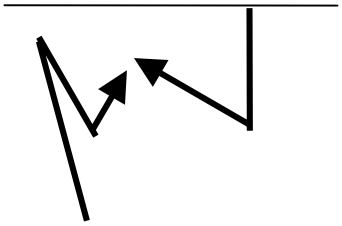
Scenario 5:



Target with crossing course and a risk of collision (CPA = 0);
After 7 min a reduction of own speed, target reduces accordingly (CPA = 0); after 13 min own course is changed 90 ^{0} to port so that CPA > 0.

Plot Nº	Time (s)	Own Ship		Marker		Target Data					
		SPD (kt)	CSE (^{0})	RNG (nm)	BRG (^{0}) t	SPD (kt) r	CSE (^{0}) r	SPD (kt) t	CSE (^{0}) t	CPA (nm)	TCPA (min)
1	0,00	25	45	5,00	30,00						
2	3,00	25	45	3,80	30,00	24,0	210,0	6,5	118,7	0,0	9,5
3	6,00	25	45	2,60	30,00	24,0	210,0	6,5	118,7	0,0	6,5
	7,00	**15**	**45**	**2,20**	**30,00**	**24,0**	**210,0**	**6.5**	**118,7**	**0,0**	**5,5**
4	9,00	15	45	1,72	30,00	14,4	210,0	3,9	118,7	0,0	7,2
5	12,00	15	45	1,00	30,00	14,4	210,0	3,9	118,7	0,0	4,2
	13,00	**15**	**315**	**0,76**	**30,00**	**14,4**	**210,0**	**3,9**	**118,7**	**0,0**	**3,2**
6	15,00	15	315	0,88	74,03	18,8	131,7	3,9	118,7	0,7	- 1,5
7	18,00	15	315	1,59	103,83	18,8	131,7	3,9	118,7	0,7	- 4,5

Scenario 6:



Target with opposite course manoeuvres to a collision course (CPA = 0);
After 13 min own speed and course is changed; target changes its course accordingly (CPA=0).

Plot Nº	Time (s)	Own Ship		Marker		Target Data					
		SPD (kt)	CSE (^{0})	RNG (nm)	BRG (^{0}) t	SPD (kt) r	CSE (^{0}) r	SPD (kt) t	CSE (^{0}) t	CPA (nm)	TCPA (min)
1	0,00	15	180	5,00	217,00						
2	3,00	15	180	4,05	229,17	27,0	357,8	12,0	355,0	3,2	5,6
3	6,00	15	180	3,37	247,37	27,0	357,8	12,0	355,0	3,2	2,6
4	9,00	15	180	3,08	247,37	5,8	67,4	13,8	157,4	0,0	32,1
5	12,00	15	180	2,80	247,37	5,8	67,4	13,8	157,4	0,0	29,1
	13,00	**10**	**290**	**2,70**	**247,37**	**5,8**	**67,4**	**13,8**	**157,4**	**0,0**	**28,1**
6	15,00	10	290	2,05	247,37	19,4	67,4	13,8	38,1	0,0	6,3
7	18,00	10	290	1,08	247,37	19,4	67,4	13,8	38,1	0,0	3,3
8	21,00	10	290	0,11	247,37	19,4	67,4	13,8	38,1	0,0	0,3

Annex C
(normative)

Electronic plotting video symbols (EPVS)

C.1 General

C.1.1 IMO Resolution MSC.64(67) annex 4 for marine radar, requires that certain indications and alarms are given on electronic plotting aids for anti-collision purposes.

Video symbols 1, 4, 6, 8 and 12, illustrated in this annex, shall be used on EPA.

C.1.2 The size of the video symbols in the text assumes a 340 mm effective diameter display. Where the size of alpha-numerics are not specified, they shall be not less than 6 mm high. For smaller diameter displays the size may be proportionally smaller.

C.1.3 Other symbols may be used for other anti-collision functions provided they do not conflict with EPVS of IEC 60872-1, navigational symbols for radar (annex E of IEC 60936 series) and IHO chart symbols (IHO S-52). The use of these other anti-collision symbols shall be limited to ensure that they do not obscure the anti-collision requirements of the electronic plotting aids.

C.1.4 If two or more symbols simultaneously apply to a target, then the symbols may be displayed together provided that they are clearly distinguishable.

C.1.5 CPA / TCPA alarm (symbol 8) is to be used for any plotted target which is predicted to close within a minimum range and time chosen by the observer.

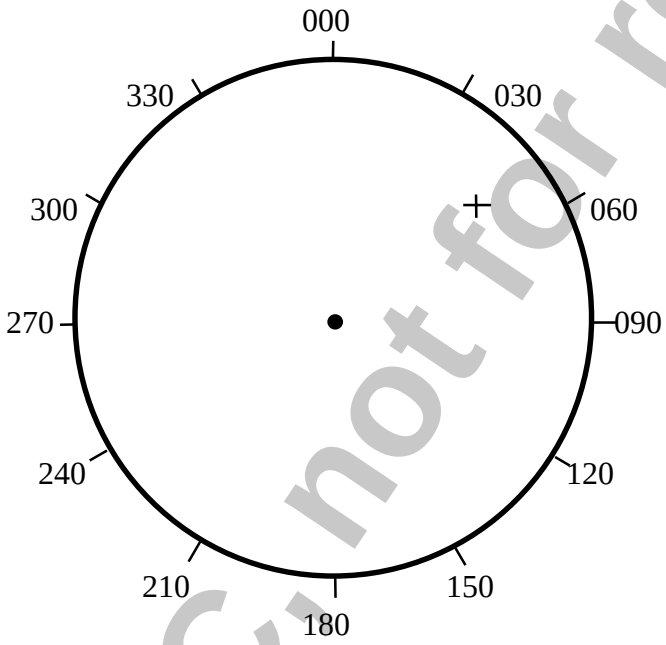
C.1.6 Additional ARPA or ATA facilities, not mandated in this EPA symbol annex, may be provided. Such facilities shall comply with annex E of IEC 60872-1or IEC 60872-2 as applicable.

C.2 Symbols

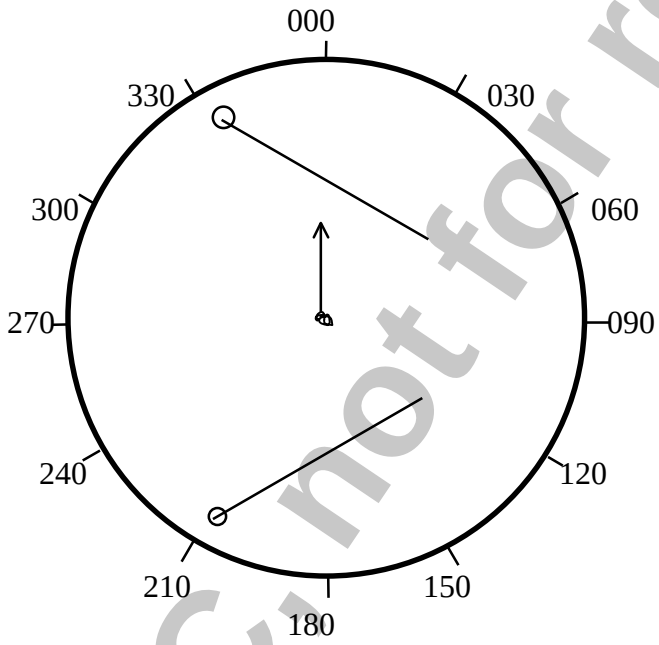
The following symbols are graphically presented within a representation of a radar plotting display, which includes a bearing scale graduated at nominal 30 ° intervals. In practice the bearing scale is divided into marks at least every 5 ° (see IEC 60936-1).

The diagrams that follow are intended to illustrate only the form of the symbols.

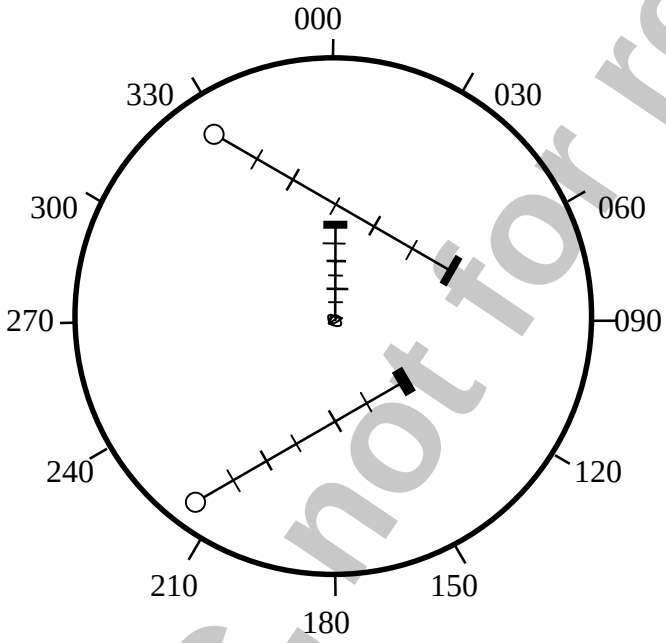
C.2.1 Symbol 1

IMO/IEC references	EPVS Symbol number	Detail	Description of symbol
3.2.1 of IMO A.823 3.3.2.1 of IEC 60872-1 3.3.2.1 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**1** ARPA ATA EPA	Manual acquisition and plotting	A cross shall be used as the cursor for manual acquisition on an ARPA and ATA and for plotting on an EPA
			NOTES 1. The cross shall be at least 10 mm in height and 10 mm in width, to avoid confusion with other navigational and chart symbols, as well as for electronic chart display and information system (ECDIS) harmonisation. 2. The cursor is also used for other radar purposes.

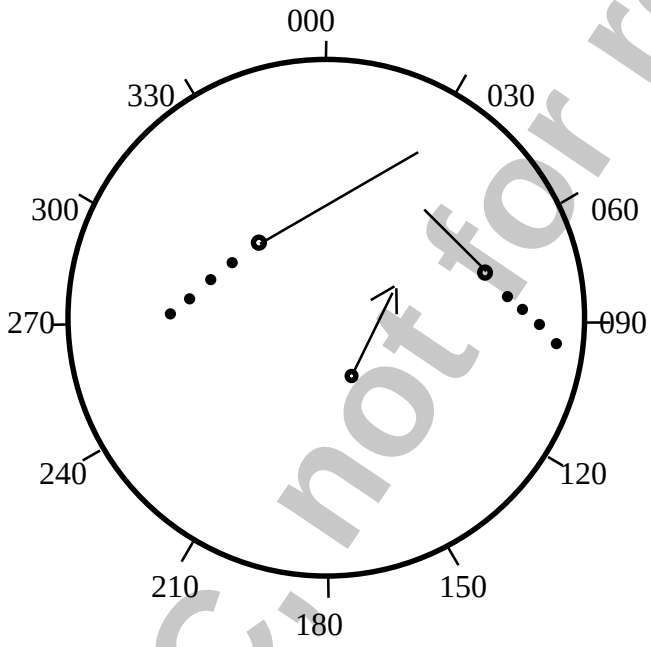
C.2.2 Symbol 4A

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823 3.3.4.6 of IEC 60872-1 3.3.4.6 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**4A** ARPA ATA EPA	Course and speed vector. Target being tracked when tracking is in steady state. *The course and speed information generated by the ARPA*/ATA/EPA *for targets* shall *be displayed in vector or graphic form.*	A vector indicating the target's predicted true or relative motion, which may have a fixed time scale or time-adjusted scale. The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter. The position of own ship shall always be indicated by a dot.
			NOTE - Optionally an open arrow or a double arrow may be added, if chosen by the user, to the end of own ship true vector. This is to indicate that all the vectors are sea stabilised to show course and speed through water (single arrow) or ground stabilised to show course and speed over the ground (double arrow) respectively.

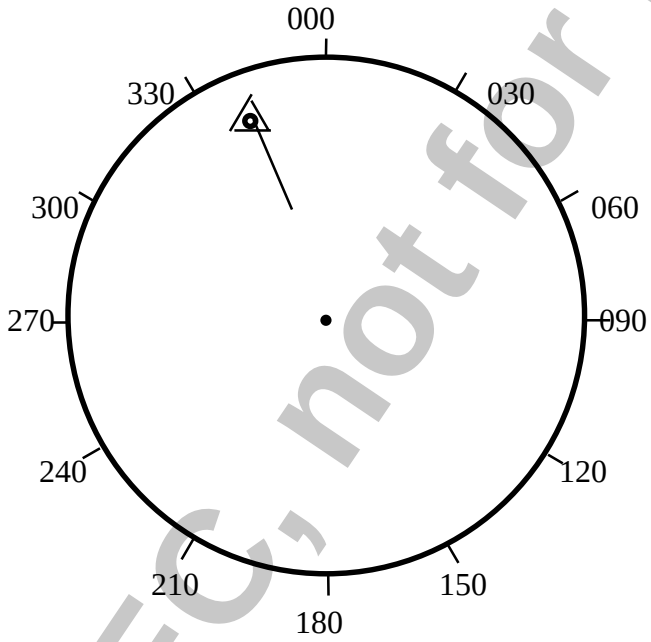
C.2.3 Symbol 4B

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823 3.3.4.6 of IEC 60872-1 3.3.4.6 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**4B** ARPA ATA EPA	Course and speed vector. Target being tracked when tracking is in steady state. *The course and speed information generated by the ARPA*/ATA/EPA *for targets* shall *be displayed in vector or graphic form.*	As for vector indicating the target's predicted true or relative motion, which may have a fixed time scale or time-adjusted scale. The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter.
			NOTE 1 - Optionally an open arrow or a double arrow may be added, if chosen by the user, to the end of own ship true vector. This is to indicate that all vectors are sea stabilised to show course and speed through the water (single arrow) or ground stabilised to show course and speed over the ground (double arrow) respectively. NOTE 2 - Marks at 1min intervals. Bold mark at 6 min intervals. Length represents user-selectable period applied to ALL vectors.

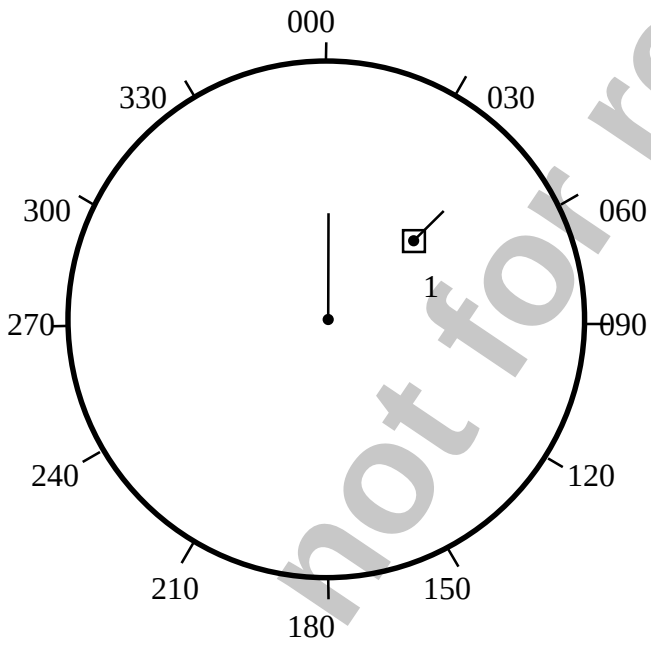
C.2.4 Symbol 6

IMO/IEC references	EPVS Symbol Number	Detail	Description of symbol
3.3.5 of IMO A.823	**6**	Past position of target on ARPA.	At least four equally time-spaced past positions to be shown on request as dots on an ARPA.
3.3.3.8 of IEC 60872-1	ARPA	*The ARPA* shall *be able to display on request at least four equally time-spaced past positions of any targets being tracked over a period appropriate to the range scale in use.*	An associated plot number adjacent to the initial plot and subsequently adjacent to the vector origin shall identify plot positions.
3.3.5.1 of IEC 60872-3	EPA	Plot position of targets on EPA.	On EPA, the past plot positions may not be equally time-spaced and are not shown astern of own ship
			This diagram applies to EPA only. For ARPA see IEC 60872-1

C.2.5 Symbol 8

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.5.2 of IMO A.823 3.3.5.6 of IEC 60872-1 3.3.5.6 of IEC 60872-2 3.3.13.1 of IEC 60872-3	**8** ARPA ATA EPA	CPA /TCPA alarm. *The ARPA/ATA/*EPA shall, *have the capability to alarm the observer with a visual and audible signal of any tracked target which is predicted to close within a minimum range and time chosen by the observer. The target causing the alarm* shall *be clearly indicated on the display.*	A flashing equilateral triangle, apex top, shall be used to mark the target. In addition, the target vector may be flashed.
			NOTE 1 - Flashing is at a frequency of about 0,5 Hz to 4 Hz. NOTE 2 - After acknowledgement it is permissible to cease flashing.

C.2.6 Symbol 12

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.6.1 of IMO A.823 3.3.6.1 of IEC 60872-1 ARPA 3.3.6.1 of IEC 60872-2 ATA 3.3.10 of IEC 60872-3 EPA	**12**	Data requirements *Targets selected* shall *be marked with the relevant symbol on the radar display. If data is required for more than one target at the same time each symbol* shall *be separately identified, for example with a number adjacent to the symbol.*	A square is to be used as a symbol to mark the data reading target.
			

Annex D
(normative)

Implementation of manual plotting

This annex describes how manual plotting shall be implemented.

D.1 The operator positions a first plot over the centre of the target video at position p_1 and time t_1. After an appropriate period of time a second plot (plot 2) is positioned over the current centre of the target video at position p_2 and time t_2. These positions are stored on a conceptual grid that models the earth's surface or the surface of the water, depending on the method of stabilisation being used (ground or water). After the second plot has been added the target's velocity is calculated using:

$$v_1 = (p_2 – p_1) / (t_2 - t_1)$$

A vector is then drawn at the position of the second plot with its length related to the velocity of the target. The vector is then drawn at the position of the second plot with its length related to the velocity of the target. The vector is periodically updated in the video circle using the assumption that the target has constant velocity. It can show the target's true or relative motion and the operator can alter its length (in minutes).

D.2 Over a period of time discrepancies between the position of the target video and the origin of the vector can build up. These can be as a result of errors in the original plot positions, or as result of a change in velocity of the target. If the operator considers that the discrepancy is significantly large a new plot (plot 3) can be made on the current centre of the video. The velocity is then recalculated using the last two plots made:

$$v_2 = (p_3 - p_2) / (t_3 - t_2)$$

The vector origin is reset to the position of the latest plot (plot 3) and the target's velocity is set to v_2.

D.3 With reference to figure D1 below, it can be seen that after the third plot the target's position and velocity are set to the best available estimates. Additionally, the operation is intuitive to the operator as small positional errors between the position of the target video and the vector origin are translated to small changes in position and velocity of the target after a corrective plot is added. Larger positional errors translate to larger changes in the position and velocity of the target. The target vector will then continue to be updated without the addition of a fourth plot until the errors grow again.

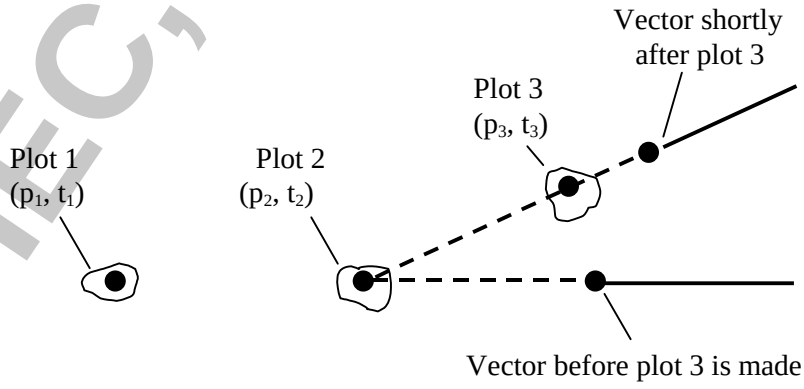


Figure D1 - Diagram of three plots

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